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ABSTRACT

The course outlined is the second of two designed to help a trainee acquire the knowledge and become proficient in the skills associated with the overhaul, inspection, and repair of reciprocating engines. The knowledge and skills are necessary to pass the Powerplant Theory and Maintenence section of the Federal Aviation Administration examination for the powerplant mechanic's license. The course is composed of one block of several units requiring one quinmester of 135 hours. Seven pages of course outline are followed by five pages of specific behavioral objectives; a posttest is appended. Basic and supplementary references, Federal Aviation Agency publications, and five instructional films are included in the bibliography. (Author/AJ)

ED 092695

AUTHORIZED COURSE OF INSTRUCTION FOR THE QUINMESTER PROGRAM

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AVIATION MECHANICS (Power Plant)
(Overhaul, Inspection and Repair of Reciprocating Engines II)

Department 48 - Course 9055.02

CE 001 112 4

DADE COUNTY PUBLIC SCHOOLS
DIVISION OF INSTRUCTION • 1971

ED 092695

D A D E C O U N T Y P U B L I C S C H O O L S

1 4 1 0 N O R T H E A S T S E C O N D A V E N U E

M I A M I, F L O R I D A 33132

Course Outline

AVIATION MECHANICS (Power Plant)
(Overhaul, Inspection and Repair of Reciprocating Engines II)

Department 48 - Course 9055.02

the division of

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Miami, Florida 33132

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Course Description

9055	48	9055.02	Overhaul, Inspection and Repair of Reciprocating Engines II
State Category	County Dept.	County Course	Course Title

A continuation of course 9055.01 with emphasis on the practical application of theories presented.

Indicator of Success: Successful completion of courses 9073.01, 9073.02, 9073.03, 9073.04 and 9055.01.

PREFACE

The course outline that follows has been prepared as a guide to help the trainee acquire the knowledge and become proficient in the skills associated with the overhaul, inspection and repair of reciprocating engines. This course is the second of two courses on the overhaul, inspection and repair of reciprocating engines. Successful completion of this course plus courses 9055.01, 9055.03, 9055.04 will provide the trainee with the skills and knowledge required to pass the Powerplant Theory and Maintenance section of the Federal Aviation Administration examination for the Powerplant Mechanic's License. Courses 9073.01, 9073.02, 9073.03, 9073.04 and 9055.01 are prerequisites for this course. This course is composed of one block of several units requiring one quinmester of 135 hours.

Great emphasis will be placed on the use of audio visual aids and instruction sheets of various types. A list of behavioral objectives the trainee will be required to perform is included. Following each unit title will be found in parentheses several letters and numbers designating the time spent in terms of theory and shop work. EIT indicates estimated instructional time, T indicates time spent in theory or classroom work and L/S indicates time spent in laboratory or shop work.

The level 1 following a unit indicates the student must have knowledge of general principles but no practical application nor manipulative skill, and instruction is given by lecture, demonstration, and discussion.

The level 2 following a unit indicates the student must have knowledge of general principles and limited practical application; sufficient manipulative skill to perform basic operations; and instruction is given by lecture demonstration, discussion and limited practical application.

The level 3 following a unit indicates the student must have knowledge of general principles and performance of a high degree of practical application, and sufficient manipulative skill to accomplish return-to-service operations. Instruction is given by lecture, demonstration, discussion, and a high degree of practical application.

This outline was developed through the cooperative efforts of the instructional and supervisory personnel, the Quinmester Advisory Committee, and the Vocational Teacher Education Service, and has been approved by the Dade County Vocational Curriculum Committee.

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with Suggested Hourly Breakdown

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GOALS

The aviation maintenance technician must be able to demonstrate:

1. Knowledge of engine operation and construction techniques.

2. The various procedures necessary to overhaul, inspect, and repair reciprocating engines.

3. Knowledge of methods of engine inspection.

4. Knowledge of methods of engine overhaul.

5. The ability to locate information in manufacturer's overhaul and maintenance manuals and utilize same.

6. The ability to assume the responsibilities necessary to become an aviation maintenance technician.

Course Outline

AVIATION MECHANICS (Power Plant)
(Overhaul, Inspection and Repair of Reciprocating Engines II)

Department 48 - Course 9055.02

I. RECIPROCATING ENGINE OVERHAUL PROCEDURES (135 hours)

A. Overhaul Reciprocating Engine
(Level - 3) (EIT-55 hrs) (T-14 hrs) (L/S-41 hrs)

1. Preparing a Work Station and Engine for Overhaul
   a. Engine work station
      (1) Select proper stand for engine to overhaul
      (2) Check for hazards that can be created in work area
      (3) Guard against contamination to engine parts in the work area
      (4) Selection of proper parts racks and reasons
   b. Preparation of engine
      (1) Pre-cleaning procedure
      (2) Means of locating parts to point of removal
      (3) Means of hoisting engine
      (4) Marking of special location of parts
      (5) Procedure for installing engine in work stand
      (6) Procedure for draining and inspecting engine oil and screens
      (7) Preparing engine for shipping containers
2. Overhauling the Reciprocating Engine
   a. Equipment
      (1) Hand tools required
      (2) Power equipment required
      (3) Type and advantage of overhaul stands
      (4) Special tools
   b. Disassembly
      (1) Determining disassembly procedure for engine type
      (2) Technique for removing frozen fasteners
      (3) Protection of engine parts during disassembly
      (4) Separating parting surfaces with gaskets of "O" rings

I. RECIPROCATING ENGINE OVERHAUL PROCEDURES (Contd.)

c. Parts storage
   (1) Means of storing parts
   (2) Correct labeling of parts
   (3) Correct grouping of parts

d. Cleaning
   (1) Methods of cleaning parts
   (2) Degreasing and decarbonizing
   (3) Cleaning internal passages
   (4) Use of gunk
   (5) Abrasive cleaning
   (6) Cleaning of ball and roller bearings
   (7) Magnetic affect on bearings
   (8) Drying and protecting bearings

e. Inspection procedures
   (1) Checking for backlash, fits and clearances
   (2) Checking studs
   (3) Identification of
      (a) Flaking
      (b) Pitting
      (c) Galling
      (d) Excessive wear
      (e) Loose liners
   (4) Inspection of bushings
   (5) Checking bushings for cracks, scoring, overheating, looseness and excessive wear
   (6) Inspection techniques for crankcase, brackets, adapters, sumps and cover plates for cracks, nicks, breaks, surface smoothness, of parting surfaces, obstructions in drill passages, tightness of plugs and mutilation of internal threads
   (7) Checking gears for wear pattern, pitting fatigue and cracks
   (8) Checking shafts for runout and conditions of threads, splines and journals as well as for wear and fatigue
   (9) Inspect oil pipes for dents, cracks, nicks, flange condition and fit
   (10) Procedure for magnafluxing
   (11) Procedure for zyglo inspection
   (12) Dy-check and its use
   (13) Visual inspection using a magnifying glass

I. RECIPROCATING ENGINE OVERHAUL PROCEDURES (Contd.)

f. Inspection sheet and tables of limits used in overhaul
   (1) Use of table of limits and who determines them
   (2) The use of the table of limits
   (3) Engine overhaul forms, the measurements recorded on overhaul forms, and the limits found there

g. The use of inspection gauges, indicator and devices
   (1) The use of micrometers, hole gauges and telescoping gauges for engine parts inspection
   (2) Checking runout with dial indicator
   (3) The use of go-no-go gauges

h. Approved engine repairs
   (1) Acceptable repairs for various engine parts
   (2) Techniques in replacing parts requiring temperature differential
   (3) In replacing parts check for meeting manufacturer's standards and mating of parts when necessary

i. Engine assembly
   (1) Procedure for assembly
   (2) Torque and clearance limits
   (3) Assembly procedure and checking for opposed engines
   (4) Internal and external safetying
   (5) Engine internal timing
   (6) Installation of accessories and external timing
   (7) Preparing engine for storage

B. Inspection and Repair of Reciprocating Engines (Level - 3) (EIT-80 hrs) (T-28 hrs) (L/S-52 hrs)
   1. Cylinder Inspection
      a. Techniques of cylinder inspection
         (1) Checking for out of round, taper and choke
         (2) Color coding of aircraft cylinders
         (3) Checking the areas of greatest wear in a cylinder

I. RECIPROCATING ENGINE OVERHAUL PROCEDURES (Contd.)

b. Limits and tolerances
(1) Where to find limits for dimensional inspection
(2) The limits that would apply to a cylinder

2. Detection of Cracks and Defects in Crankcase Assemblies
a. Cleaning crankcase assemblies
(1) Materials generally used in crankcase cleaning
(2) Handling and cleaning of crankcase made of special alloys
b. Inspection of crankcase assemblies
(1) Types of specialized inspection
(a) Zyglo
(b) X-ray
(c) Dy-check
(2) Oil flow check procedure
(3) Removal and installation of plugs in crankcase passageways
(4) The use of visual inspection and dimensional inspection

3. Stud Removal and Installation
a. Removal of damaged studs
(1) Tools used in stud removal
(2) Procedure used in stud removal
b. Removal of broken studs
(1) Tools used to remove broken stud
(2) Procedures used for removal of broken stud
(3) Procedure for special alloy
c. Installing studs
(1) Identify oversized studs
(2) Identify alloy of studs
(3) Installation without special tools
d. Helicoil
(1) Description of a helicoil
(2) Usage
(3) Installation
(4) Removal

4. Identification of Serviceable Bearing
a. Visual inspection of bearing
(1) Indication of acid etch
(2) Source of acid etch
(3) Effect of inadequate lubrication on bearings

(4) Effect of oil pressure in engine with worn bearing
(5) Effect of bearing misalignment during installation on bearing wear

b. Dimensional inspection of bearing
(1) Inside diameters
(2) Outside diameters

5. Crankshaft Inspection
a. Crankshaft runout
(1) Flange - checking runout before disassembly
(2) Shaft
(a) Use of v-block or rollers when checking shaft runout
(b) Checking center mains for alignment
(c) Use of dial indicator on a crankshaft

b. Measurements
(1) Procedures for measuring bearing journals
(2) Determining out of round of journals
(3) After dimensional inspection x-ray crankshaft

6. Piston and Knuckle Pin Retainers
a. Piston pin retainers
(1) Full-floating piston pin
(2) Types of piston pin retainers
(3) Procedure for removal and installation

b. Knuckle pin retainers
(1) Determine the serviceability of knuckle pin retainers
(2) Pre-positioned knuckle pins

7. Cams and Cam-Followers
a. Cam rings
(1) Number of cam tracks per ring or plate
(2) Purpose of a ramp on a cam lobe

b. Cam shafts
(1) Types of engines that use cam shafts
(2) Number of lobes used on a shaft in relation to numbers of valves in the engine
(3) Procedure for measuring cam lobe height

I. RECIPROCATING ENGINE OVERHAUL PROCEDURES (Contd.)

c. Cam followers
(1) Zerolash valve lifters
(2) Interchangeability of parts of a zero-lash valve lifter
(3) Effect of flat or stuck lifters on valve operation

8. Valve and Valve Seat Inspection and Rework
a. Valve types and materials
(1) Aircraft exhaust valve requirements
(2) Aircraft intake valve requirements
(3) The purpose of sodium filled valves
(4) The hazards in sodium filled valves
(5) The use and advantage of stellite in valve construction
b. Valve seat and face angle
(1) The purpose of valve face angle
(2) The normal angle for exhaust valve and intake valve
(3) Valve seat construction
(4) Means of retaining valve seats in cylinder head
c. Valve guides
(1) Valve guide installation procedure
(2) The relationship of valve to the seat and guide
(3) Valve seat installation procedure
(4) Determining valve stretch
(5) Method of obtaining a gas tight seal between the valve and its seat
(6) The desired width of contact between the valve and seat

9. Cylinder Assembly Installation and Construction
a. Construction features
(1) Piston
(a) Cam ground pistons
(b) The reason for large piston to cylinder wall clearances
(c) Types of pistons
(2) Rings
(a) The function of a piston ring
(b) The reason for ring clearance

I. RECIPROCATING ENGINE OVERHAUL PROCEDURES (Contd.)

(3) Ring, piston, and cylinder fit
(a) The reason for chrome plating rings
(b) Precautions used with chrome rings
(c) Ring side clearance
(d) Ring end gap
(e) Procedure for checking different ring types

b. Use of manuals
(1) Procedures
(a) Cylinder attaching methods
(b) Installing the master rod cylinder
(c) Checking rings before cylinder installation
(d) Checking crankcase base area before cylinder installation
(e) Lubrication of cylinders, piston, and ring assemblies
(f) Ring compressors
(g) Cylinder hold down types
(2) Special tools
(a) Tools for torquing cylinder hold down nuts
(b) Torquing sequence for cylinder hold downs

II. QUINMESTER POST TEST

BEHAVIORAL OBJECTIVES

BLOCK I - RECIPROCATING ENGINE OVERHAUL PROCEDURES

A. Overhaul Reciprocating Engine

1. Preparing a Work Station and Engine for Overhaul

Given:

A written list of twenty safe and unsafe practices (normally associated with handling of engine and the preparation of a work station prior to engine overhaul), an engine and a work station.

Performance:

The student will recognize all hazardous conditions and arrange the engine in the work station for an engine overhaul.

Standard:

All hazardous practices will be identified. The sequence of operations to prepare the work station will be in general agreement with common industry practice.

2. Overhauling the Reciprocating Engine

Given:

A small opposed or radial engine, a work station having an engine overhaul stand and necessary tables and parts racks, necessary hand and specialized tools and fixtures, an overhaul manual and overhaul inspection sheets.

Performance:

Using the overhaul manual, the student will disassemble the engine, label and store the parts, clean the parts, inspect the parts physically, visually, and with a nondestructive testing; measure the parts for wear and identify those parts that are reusable from the table of limits; reassemble the engine; and record all findings and recommendations on the overhaul inspection sheets.

Standard:

All procedures followed, recorded data on the overhaul inspection sheets, and recommendations for parts rejection will be correct for the particular engine and the engine will be assembled mechanically correct.

B. Inspection and Repair of Reciprocating Engines

1. Cylinder Inspection

Given:

A cylinder from an aircraft engine, appropriate inspection tools and reference manuals.

Performance:

The student will inspect and determine the serviceability of a cylinder.

Standard:

The student will correctly judge whether the cylinder should be rejected or returned to service.

2. Detection of Cracks and Defects in Crankcase Assemblies

Given:

Written list of probable defects, crankcases that exhibit one or more of the defects, and the necessary inspection equipment.

Performance:

Provided with a list of the probable defects, the student will clean, visually inspect and detect the defects present in the specimen crankcase assemblies.

Standard:

The student will detect all the defects in the crankcase assemblies.

3. Stud Removal and Installation

Given:

An aircraft engine component that has a damaged or broken stud and the necessary tools.

Performance:

The student will remove a damaged stud and install a replacement stud.

Standard:

Removal of the damaged stud will not cause further damage to the component. The replacement stud will maintain a class three fit.

4. Identification of Serviceable Bearings

Given:

A random display of bearings which may display evidence of impending failure, an applicable table of limits and tolerances and the necessary inspection tools.

Performance:

The student will identify serviceable bearings by means of visual and dimensional inspection. He will also identify failed or failing bearings within the displayed group of bearings, and when given a written list indicating where these bearings are located within an engine, will describe how these bearings could be detected in an operating engine.

Standard:

Inspection procedure and measurements will meet return-to-service quality.

5. Crankshaft Inspection

Given:

A crankshaft from an aircraft engine, the necessary inspection tools and reference manuals.

Performance:

The student will check crankshaft "run-out", measure rod and main bearing journals and judge whether the crankshaft meets dimensional tolerances.

Standard:

Inspection procedure and measurements will meet return-to-service quality.

6. Piston and Knuckle pin Retainers

Given:

Piston, piston pins, master rods and knuckle pins with various types of pin retainers and the applicable manufacturer's manuals.

Performance:

Provided with examples of the various types of pistons and knuckle pin retainers, the student will correctly name and identify each type. He will remove and reinstall at least one type of retainer.

Standard:

Removal and reinstallation of the retainer will be in accordance with the procedure specified in the manual and will be accomplished without damaging the retainer or engine part.

7. Cams and Cam-followers

Given:

A typical camshaft, cam ring, cam-followers, the precision measuring tools and appropriate reference information.

Performance:

The student will identify the components dimensionally inspect and describe the operation of the valve mechanisms. He will disassemble, assemble and test zero-lash lifters.

Standard:

Correct nomenclature will be used to identify the components and describe the operation of valve mechanisms. Measurements will be accurate but components need not be of return-to-service quality.

8. Valve and Valve Seat Inspection and Rework

Given:

An aircraft engine cylinder containing valves, valve springs, appropriate reference information and the required tools.

Performance:

The student will inspect the valve assemblies, reface and reseat the valves. He will interpret the manufacturer's overhaul instructions and describe the replacement of valve guides and seats.

Standard:

The refaced and reseated valves will not leak when checked in accordance with manufacturer's overhaul instructions.

9. Cylinder Assembly, Installation and Construction

Given:

A piston, pin, rings, cylinder assembly, seals gaskets, necessary tools and reference manuals.

Performance:

The student will describe the construction features of a piston, rings, and cylinder assembly. He will inspect the components, fit the pins and rings to the piston and install the assembly in the cylinder and torque the cylinder to the engine.

Standard:

The student will use correct nomenclature and terminology as part of the description and explanation. All work will be in accordance with the manufacturer's specifications.

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2. Northrop Institute of Technology. Powerplants for Aerospace Vehicles. 3rd ed. New York: McGraw-Hill Book Company, Inc., 1965. Pp. 480.

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1. Brimm, Daniel J. and Boggess, H. Edward. Aircraft Engine Maintenance. 1st ed. New York: Pitman Publishing Corp., 1940. Pp. 470.

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1. Federal Aviation Administration. Acceptable Methods, Techniques, and Practices-Aircraft Inspection and Repair, Advisory Circular 43.13-1. Washington,

D.C.: U.S. Government Printing Office, 1965. Pp. 232.

2. Federal Aviation Administration. Acceptable Methods, Techniques, and Practices-Aircraft Alterations. Advisory Circular 43.13-2. Washington, D.C.: U.S. Government Printing Office, 1965. Pp. 74.

3. Federal Aviation Administration. Aircraft Engine and Propeller Type Certificate Data Sheets. Washington, D.C.: U.S. Government Printing Office, 1968.

4. Federal Aviation Administration. Aircraft Type Certificate Data Sheet and Specifications. Washington, D.C.: U.S. Government Printing Office, 1967.

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7. Federal Aviation Administration. Summary of Supplemental Type Certificates. Washington, D.C.: U.S. Government Printing Office, 1965.

Films:

1. Inspection and Reconditioning Piston Assembly. 16mm. 20 min. Black and White. Sound. G.T.B. 3-29.

2. Inspection and Reconditioning of Valve Assembly. 16mm. 15 min. Black and White. Sound. G.T.B. 3-21.

3. Overhauling the Crankshaft Assembly. 16mm. 14 min. Black and White. Sound. G.T.B. 3-30.

4. Reassembling the Engine. 16mm. 1[illegible] min. Black and White. Sound. G.T.B. 3-25.

5. Wright Engine Preliminary Disassembly. 16mm. 13 min. Black and White. Sound. G.T.B. 2-3.

A P P E N D I X

Quinmester Post Test Sample

Quinmester Post Test

Name_____ Date_____ Score_____

Multiple Choice Test Items

Each question is followed by four possible answers, select the best answer and mark your answer sheet accordingly.

1. How is the gap in a piston ring measured?
    1. No measurement is required if the proper ring is installed
    2. With a depth gauge while the ring is held in place on the piston
    3. With a thickness gauge while the ring is installed inside the cylinder
    4. With a go-no-go gauge while the ring is installed on the proper mandrol

2. How is the oil that is picked up by the oil control rings returned to the sump?
    1. By machined grooves in the piston skirt
    2. Through oil holes drilled in the ring grooves
    3. Through holes in the piston pin
    4. It remains trapped between the oil scraper rings

3. Valve guides are installed in the cylinder head by
    1. evets press
    2. threading
    3. shrinking
    4. sweating

4. Piston rings should be installed
    1. with all ring joints in line
    2. with all ring joints staggered
    3. with no clearance between ring joints
    4. with no clearance between ring joints and ring grooves

5. Which of the following would be an acceptable condition for a reconditioned cylinder?
    1. A cracked cylinder head
    2. A cracked rocker arm boss
    3. Improper cleaning after reboring
    4. A cracked cylinder head cooling fin

6. Small scores or scratches on the head or lands of an aluminum piston may be removed by
    1. using a rotary wire brush
    2. using a fine grade file
    3. stoning only the excessive build up around the scratch
    4. hand stoning or using crocus cloth

7. The greatest wear in a cylinder is at the
    1. center
    2. top
    3. center near the bottom
    4. bottom of a slanted cylinder

8. What is the correct method to use when inspecting intake and exhaust valves for stretch?
    1. Place the valve on a flat surface and measure the stem with a verier height gauge
    2. Measure the stem length with an outside micrometer caliper
    3. Use a contour or stretch gauge
    4. Use a valve depth gauge

9. On a single row radial engine, why should the knuckel pins be fastened securely?
    1. So that the oil holes will not become misaligned
    2. To minimize wear
    3. To prevent slippage between the articulated rod and pin
    4. To reduce torsional vibration caused by engine firing impulses

10. Why are floating pins used in aircraft pistons?
    1. To allow movement between pin and piston
    2. To allow movement between piston and connecting rod
    3. To allow movement between pin, piston and connecting rod
    4. To allow movement between piston and cylinder

11. Which of the following are symptoms of a weak engine?
    1. Below normal MAP required to obtain normal RPM
    2. Backfiring and or detonation
    3. Excessive MAP required to obtain normal RPM
    4. Intermittent misfiring at high RPM

12. A mechanic should know that the installation of baffles, brackets, etc., under cylinder hold down nuts and cap screws
    1. is not considered good practice and should be discouraged
    2. may cause loosening of the nuts or cap screws even though they were properly tightened and locked at installation
    3. is absolutely forbidden if parts are made from aluminum or other soft metals
    4. is not recommended since all of the above statements are true

13. Why are pistons cam ground?
    1. To allow for equal wear on the master rod
    2. For proper fit at operating temperatures
    3. To improve volumetric efficiency
    4. To equalize wear on cylinders which are not placed vertically

14. What material is used for piston compression rings?
    1. Aluminum alloy
    2. Steel alloy
    3. Cast iron
    4. Aluminum

15. How should magnesium engine parts be cleaned?
    1. In a solution of caustic soda
    2. With transpo and gunk
    3. With a neutral solvent and light scraping
    4. By sand blasting

16. Why is the piston-to-cylinder clearance greater in aircraft engines?
    1. The pistons have different rates of thermal expansion
    2. Aircraft engines run at higher RPM than other engines
    3. Aircraft engines operate at higher temperatures
    4. Compression ratios are higher and require higher clearances

17. What is the reason for a "Choke Bore" in an engine cylinder?
    1. To force the piston closed to insure a better gas seal at the top of the cylinder
    2. To insure no taper at normal operating temperatures
    3. To give added clearance to rings and pistons at high operating temperatures
    4. To allow for piston wear as the engine operates

18. The purpose of the aluminum caps in the ends of the piston pin is to
    1. form a plug so that oil can be forced into the pin for cooling
    2. prevent the pin from scoring the cylinder
    3. allow for thermal expansion of the pin
    4. steel caps are used, not aluminum

19. Carbon is most likely to form under and on
    1. the lower oil control ring
    2. all of the piston rings to approximately the same degree
    3. only on the upper oil scraper ring
    4. the topmost compression ring

20. A tapered oil control ring has been installed upside down, this will cause
    1. low oil pressure
    2. low oil consumption
    3. high oil consumption
    4. high oil pressure

21. Push rods are removed when the piston is at the
    1. top center of the compression stroke
    2. top center of the intake stroke
    3. bottom center of any stroke
    4. bottom center of the exhaust stroke

22. The undersides of pistons are finned or ridged. The basic reason for this is
    1. lighter weight
    2. greater strength
    3. better cooling
    4. a better coefficient of expansion

23. What causes the hissing noise when a propeller is pulled through by hand?
    1. Exhaust valve blow-by
    2. Worn piston rings
    3. High compression of the cylinders
    4. Improper cylinder wall lubrication

24. The valves should be adjusted for clearance at which of the following engine positions?
    1. B.D.C. of the intake stroke
    2. T.D.C. of compression stroke
    3. T.D.C. of the exhaust stroke
    4. B.D.C. of the compression stroke

25. A twin row radial engine has
    1. no cam rings
    2. one cam ring
    3. two cam rings
    4. four cam rings

KEY TO QUINMESTER POST TEST
9055.02

1.	3	9.	3	17.	2
2.	2	10.	3	18.	2
3.	3	11.	3	19.	3
4.	2	12.	4	20.	3
5.	4	13.	3	21.	1
6.	4	14.	3	22.	3
7.	2	15.	2	23.	3
8.	3	16.	3	24.	2
				25.	3